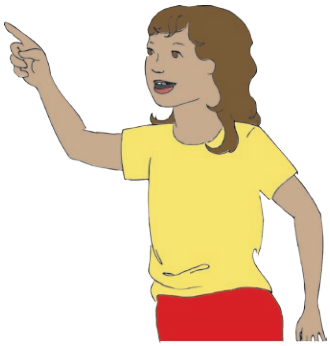
Exploration 3: How Do Rotors Create Lift?

Part 1: Air is Made of Something

Part 2: Spinning Rotors and Lift



Students learn that air takes up space and that a spinning rotor affects the air and generates lift for rotorcraft.

Main Concept

Air is a substance that surrounds us, takes up space, and whose movement we feel as wind.

Goal

Students will conduct a scientific investigation and learn that air takes up space and rotorcraft blades move the air and generate lift.

Objectives and Standards

Objectives	Standards
1. Students will conduct investigations with air and learn that air takes up space.	**Meets**: 2061: 4B (3-5) #4
2. Students will describe how rotor blades move air and generate lift.	**Partially Meets:** 2061: 4F (3-5) #1
3. Students will make scientific observations.	**Addresses**: 2061: 1B (K-2) #1
4. Students will work collaboratively with a team and share their findings.	2061: 1C (K-2) #2

Prerequisite Concepts

- A spinning rotor is required for a rotorcraft to fly.
- People can often learn about things around them by just observing those things carefully, but sometimes they can learn more by doing something to the things and noting what happens.
- Scientific investigations may take many different forms, including observing what things are like and doing experiments.

Links to Resources that Address Prerequisite Concepts

Robin Whirlybird
http://rotored.arc.nasa.gov/story/robin18.html
http://rotored.arc.nasa.gov/story/robin3.html
Click the "Rotorcraft Activities" button.

Robin Whirlybird Exploration #1: What is a Model?

Robin Whirlybird Exploration #2: How Do Rotorcraft Fly?

New Concepts

- Air takes up space and is made up of particles that are too small to see.
- Changes in speed or direction of motion are caused by forces. The greater the force is, the greater the change in motion will be.

Links to Lessons or Resources that Also Address Concepts

- Websites:
  - ☆ Aviation for Little Folks (K-4 level)
    http://spacelink.nasa.gov/Instructional.Materials/On-LineEducational.Activities/Aviation/index.html
  - ☆ How Things Fly
    http://www.nasm.si.edu/galleries/gal109/
  - ☆ How Things Fly—Air is Stuff
    http://www.aero.hq.nasa.gov/edu/airisstuff.html

Schedule

Allow 2-4 sessions of 20-30 minutes each.

Materials

Part 1:

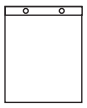
(This is a suggested list as students will have their own needs based upon their demonstrations.)

- *Protective eyewear for each student, available from most school science supply stores and catalogs*

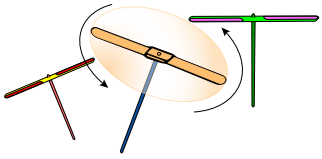
- *Chalk or tape*

- *Drawing paper and crayons or coloring pencils*

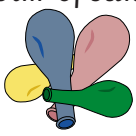
- *Chart paper*



- *One "flying dragonfly," which is a toy rotor that flies (shown right), for each pair of students*



- *Balloons*



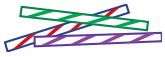
- *Empty plastic bottles or jars*

- *Wide-mouthed plastic container or bucket for water*

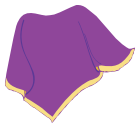
- *Video about air that can be obtained through your school district's video library*

- *Paper airplane*

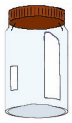
- *Drinking straws*



- *Handkerchief or small cloth*

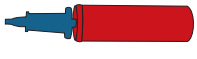


- *Plastic, clear, wide-mouth jar with lid*



- *Tub of water*

- *Hand pump*

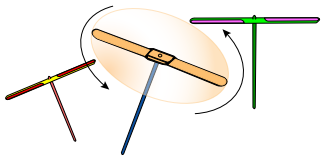


- *Small, deflated rubber ball*

Materials

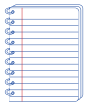
Part 2:

- One "flying dragonfly," which is a toy rotor that flies (shown right), for each pair of students

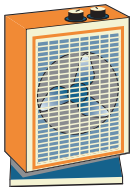


- Cellophane tape for each student group

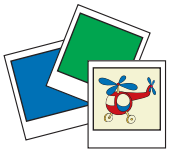
- Notebook paper sheets



- 2-5 small box fans with reversal spin switch (in which the fan blades are covered and cannot be accessed or reached by small hands or fingers)



- Picture of a room with a wood-burning stove



Safety Precautions

When using flying objects in a classroom, post very strict rules and review them with the students. All students MUST wear protective eyewear while any object is in flight. Clearly delineate one or more staging areas, preferably with students' input. Mark on the ground with chalk or tape, where all "test flights" will take place. Caution students to "secure the area" before beginning any "test flight."

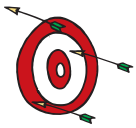
Part 1: Air is Made of Something

Engage

1. Draw on students' prior knowledge with the following questions:
   - What is inside a balloon?
   - What makes dry leaves blow about on a windy day?
   - Have you ever felt wind?
   - What is wind?
   - What is air?

   List students' answers on chart paper. These answers are their hypotheses.

2. As a class, develop a list on chart paper of the characteristics that determine that an object is "something" or that "something is here." The list could include the following characteristics or descriptors:
   - Takes up space
   - Has weight
   - Can form a shape
   - Has thickness or height or width



A common misconception is that air is empty and consists of nothing. This misconception is difficult to change with students below the 3rd grade due to their level of cognitive development. However, the misconception can be challenged through the examples given in this exploration.

Explore

1. Have students work in teams or pairs.

2. Ask students to design a demonstration that clearly shows that air is "something" or is NOT empty.

3. Have students share their demonstration design with the class and ask for input.

4. Have students revise their demonstrations based upon input and then develop a list of the materials they will need to perform the demonstration for the following session.

5. At the following session, set safety precautions before the students begin to practice their demonstrations! Distribute the protective eyewear.

6. Give students approximately 10 minutes to practice their demonstrations.

7. Ask students to draw a picture that depicts the results of their demonstration.

Explain

1. Have students present their demonstrations with their explanations to the class. Ask questions that are challenging yet appropriate to students' level of cognitive development.

   If students do not come up with convincing demonstrations here are some ideas:
   - Blow up a balloon and ask students what the balloon is filled with.
     Note to Teacher: Do not ask very young students to blow up balloons as this can be a choking hazard.

   - Half fill a plastic container with water. Plunge the plastic bottle into the water and observe the bubbles of air that come out of the plastic bottle.

2. Distribute drawing paper.

3. Ask students to work in their teams or with partners to draft a conclusion about the characteristics of air.

4. Ask students to draw a picture or diagram to illustrate what they have learned about air.

5. Collect the diagrams or pictures and use them for evaluation purposes.

6. Show the short video about air.

Extend

1. Take a paper airplane and make the statement: "Because the Earth has the kind and amount of air it has, we can do this …" Then, gently toss the paper airplane.

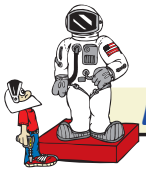
2. Encourage students to discuss this statement and their observations of the airplane's flight with their teams or partners.

3. Hand out a sheet of paper and ask students to write down their explanation of what they saw. Allow them to draft their explanation in any way they need to, for example, with a drawing or diagram with a brief explanation, concept map or narrative. Collect these explanations and post them for reference throughout the coming explorations.

Evaluate

Collect students' conclusions about the characteristics of air for evaluation. Look for characteristics that include the following:

- Air takes up space.
- Air moves.
- Air can form a shape.



Further Exploration

1. Students might have additional questions regarding the specifics of what happens with air in terms of air pressure, etc. To explore this further use the NASA CD-ROM Exploring Aeronautics:
   - How an Airplane Flies
   - Tools of Aeronautics

   This CD-ROM can be obtained from NASA CORE http://core.nasa.gov

2. Students might have additional questions regarding the Earth's atmosphere and air. They might want to compare the Earth's atmosphere with the atmosphere on the Moon or on other planets. This might lead students to question whether an airplane could fly in the atmosphere of the Moon or other planets.

Part 2: Spinning Rotors and Lift

Engage

1. Challenge your students to prove to you how air moves around a spinning rotor blade. Emphasize that the demonstration must meet your classroom safety standards and that they can use only the items you provide.

2. Review with the students the items you will allow them to use. These items are in the materials list for Part 2.

   Caution: Students should NOT use these items unless closely monitored by the teacher or a responsible adult classroom aide.

Explore

1. Set safety precautions before the students begin to explore! Make sure students have protective eyewear.

2. Allow the students working in their teams/pairs approximately 10 minutes to explore their ideas about how air moves around a spinning blade, using the materials you have provided. Monitor them closely.

Explain

1. Ask students working in their teams/pairs to draw a picture or diagram with text that depicts the results of their exploration.

2. Have each team or pair share their exploration and explanation with the class.

    - What the students may find is that when the box fan or the rotor model spins counter-clockwise (as one is facing the top of the rotor model's blades or the front of the box fan blades) the air is pulled toward the spinning blades and moves quickly through, coming out the other side forming a "wind."

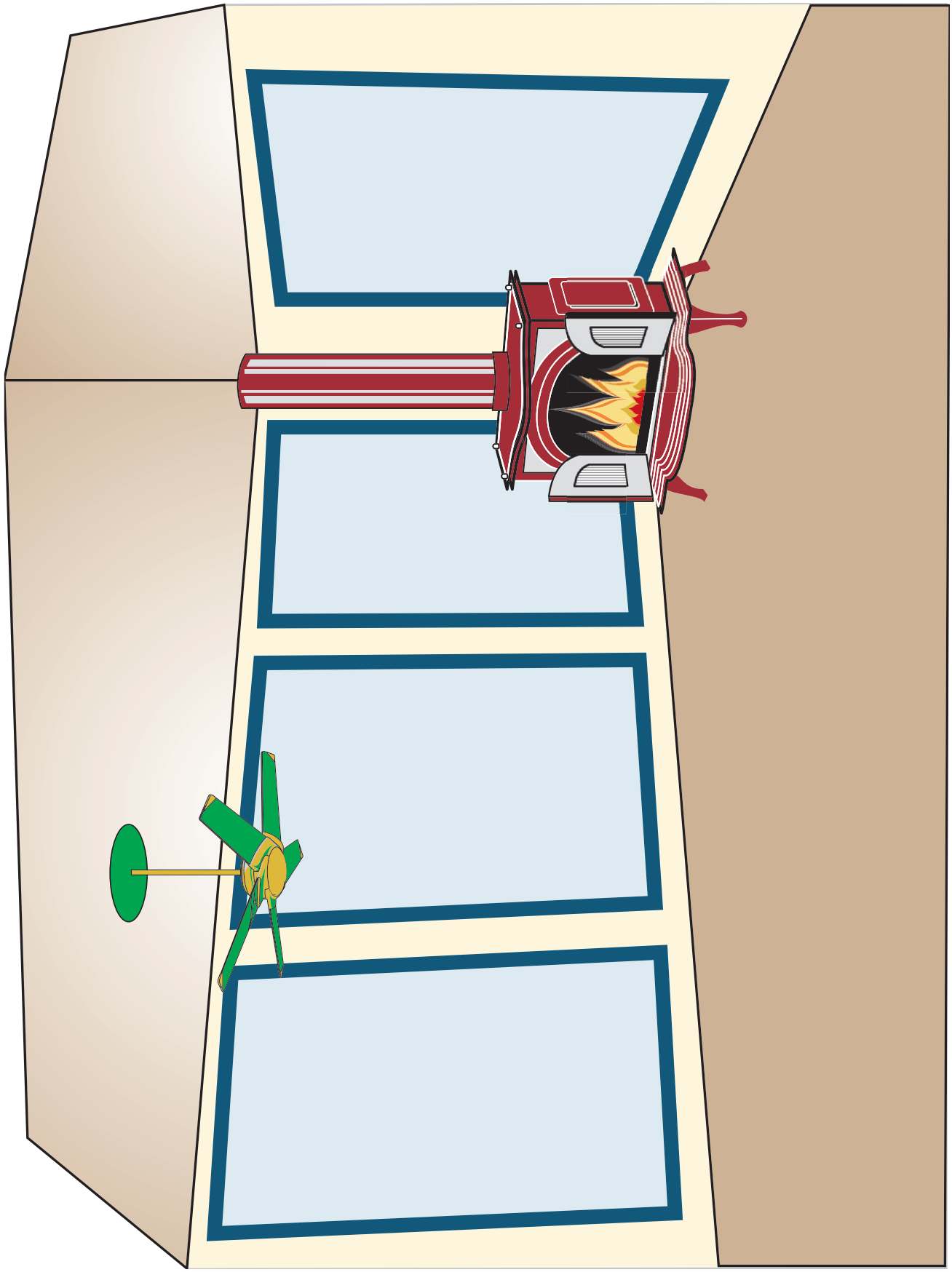
    - When either the box fan or the rotor model's blades spin clockwise (as one is facing the top of the rotor model's blades or the front of the box fan blades) the air is pushed out from the spinning blades, creating a "wind" to those standing in front of the box fan or rotor model.

3. Demonstrate the above by hanging a sheet of paper in front of the spinning blades. DO NOT allow the paper to get sucked through the protective grid and into the rotor mechanism of the fan.

4. Collect the diagrams or pictures and use them for evaluation purposes.

Extend

1. Show the students a picture of a room with a wood-burning stove for heat, a series of windows that are low to the floor, and a high-pitched ceiling with a ceiling fan hanging from the apex of the ceiling.



- Tell students that you know that if the ceiling fan turns in one direction (clockwise or counter-clockwise), the cooler air near the floor will be pulled up toward the ceiling.

- You also know that if the ceiling fan spins in the opposite direction it will push the warm air down toward the floor.

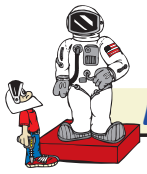
2. Ask the students to help you figure out which direction (clockwise or counter-clockwise) the ceiling fan should move in summer and winter to circulate the cool air and the warm air.

3. Encourage students to discuss their statements with their teams or partners.

4. Hand out sheets of paper and ask students to write down their explanation. Allow students to draft their explanation any way they need to, for example, with a drawing or diagram and a brief explanation, a concept map, or in narrative form.

Evaluate

- Use students' diagrams and conclusions about the airflow around a spinning rotor blade for evaluation. The diagram should show the air flowing in a direction perpendicular to the plane of the blades.



Further Exploration

Students might have additional questions regarding the specifics of what happens with air in terms of air pressure, etc. To explore this further use the following:

- Robin Whirlybird http://rotored.arc.nasa.gov/story/robin18.html
  - ☆ Click on button "Rotorcraft Activity"

- NASA CD-ROM Exploring Aeronautics:
  - ☆ How an Airplane Flies
  - ☆ Tools of Aeronautics

  (This CD-ROM can be obtained from NASA CORE http://core.nasa.gov)